AU/ACSC/133/2001-04

AIR COMMAND AND STAFF COLLEGE

AIR UNIVERSITY

THE FOG AND FRICTION OF VICTORY:

CONGRUENT TRAINING FOR COMBAT CAPABLE AIRPOWER

by

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A Research Report Submitted to the Faculty

In Partial Fulfillment of the Graduation Requirements

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Maxwell Air Force Base, Alabama

April 2001

Report Documentation Page

Report Date	Report Type	Dates Covered (from... to)
01APR2002	N/A	-

Title and Subtitle The Fog and Friction of Victory: Congruent Training for Combat Capable Airpower	**Contract Number**
	Grant Number
	Program Element Number
Author(s) Kelly, Mark D.	**Project Number**
	Task Number
	Work Unit Number
Performing Organization Name(s) and Address(es) Air Command and Staff College Air University Maxwell AFB, AL	**Performing Organization Report Number**
Sponsoring/Monitoring Agency Name(s) and Address(es)	**Sponsor/Monitor's Acronym(s)**
	Sponsor/Monitor's Report Number(s)
Distribution/Availability Statement Approved for public release, distribution unlimited	
Supplementary Notes	
Abstract	
Subject Terms	
Report Classification unclassified	**Classification of this page** unclassified
Classification of Abstract unclassified	**Limitation of Abstract** UU
Number of Pages 37	

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Preface

During fifteen years in the flying profession, I have participated in countless briefings and academic sessions on how to survive an air-to-air threat and how to kill a fixed enemy target. Comparatively little time has been spent in efforts to survive a surface-to-air threat or engage a low-contrast target. Yet surface threats historically account for the majority of Air Force casualties while every major US conflict of the twentieth century has required the engagement of battlefield targets in adverse environments.

This research paper does not attempt to address "why" the Air Force trains for the most effective *use* of airpower over the most recurring *need* for airpower. However, it does analyze the effects of that policy and provides an avenue to progress towards a more combat capable force.

I am greatly indebted to my research advisor, Colonel D. Foster Bitton, and the Air University Library staff for their assistance with the material and style of this project. I am also immensely grateful to General John Jumper, Commander, Air Combat Command and Colonel Tom Sheridan, Commandant, Air Command and Staff College, for their time, effort, and instruction on the finer points of officership and diplomacy.

I wrote this paper to help combat air force (CAF) aviators survive the threats and kill the targets that dominate the past, present, and future of airpower. It is dedicated to all of the Air Force warriors who reach for a master arm switch as part of their daily duties.

Abstract

The Air Force has employed well-trained personnel and superior technology over the past eleven years to effect decisive victories over credible, though somewhat unprepared enemy forces. The success of these operations has resulted in an increased self-confidence in US tactics and technology while it has raised societal expectations of low casualty operations. This success has also affected the daily regimen of combat air force (CAF) training programs. Despite recurring losses to surface-based threats and the continued need for all-weather close air support (CAS), CAF training overwhelmingly concentrates on surviving air-to-air threats and engaging fixed targets. CAF combat capability is reduced by the practice of training towards the most doctrinally effective *use* of airpower over the most recurring *need* for airpower. This research paper examines the recurring lessons of airpower history, analyzes current trends and threats, and then offers a training program to survive the most lethal threats and kill the most critical targets.

Since 1965, anti-aircraft artillery (AAA) and surface-to-air missiles (SAM) have claimed over 1500 Air Force aircraft while enemy MiGs have accounted for 66 USAF losses.[1] Despite this disparity in lethality, Air Force fighter training has overwhelmingly sought to master air-to-air survival skills while downplaying the more lethal surface threat. This training imbalance was greatest in the late 1970's when CAF aviators rigorously trained in conjunction with dedicated air-to-air adversary squadrons but without the benefit of dedicated surface threat adversaries. The training culminated in Operation DESERT STORM where the Air Force achieved a 31 to 0 air-to-air kill ratio while suffering 14 combat losses to surface threats[2]. The adversary training

which led to this air superiority success has now diminished to more closely reflect the limited training opportunities of the Vietnam-era.

Similarly, current CAF close air support (CAS) and air interdiction (AI) training resembles the regimen which normally dominates inter-war periods. Every major US conflict of the twentieth century has required the engagement of CAS/AI targets in adverse environments. Yet every inter-war period sees the erosion of adverse weather CAS/AI skills due to insufficient emphasis and training.

Modern trends indicate a continued need for the ability to survive surface threats and attack low-contrast targets. High opstempo/low experienced aviators face an increased proliferation of advanced SAMs. Aircrews are now required to operate in an era of casualty sensitivity and collateral damage minimization. CAF aviators also face a world of increased peace operations and urbanization. CAF training must adapt to these lessons and trends to align every sortie with the skills required for maximum survivability and lethality during expected wartime tasks. The Air Force cannot allow the ineptitude of recent adversaries to instill an ill-deserved and ill-advised US superiority complex and it cannot wait for a catastrophic military failure to provide the catalyst for innovation.

Notes

[1] Thomas A. Keaney and Eliot A.Cohen, *Gulf War Air Power Survey Volume V*. (Washington: U.S. Government Printing Office 1993),641-651. And Air Force Flight Dynamics Laboratory Air Force Systems Command, *A Comparative Analysis of USAF Fixed-Wing Losses in Southeast Asia Combat,* (Wright Patterson Air Force Base, Ohio, December, 1977), Declassified on 31 Dec 1988, 78.

[2] Ibid.

Chapter 1

Introduction - Adapt To Survive and Kill

Prejudice against innovation is a typical characteristic of an officer corps which has grown up in a well-tried and proven system.

—Field Marshall Erwin Rommel
The Rommel Papers

The US military is definitely a "well-tried and proven system." It has employed well-trained personnel and superior technology over the past eleven years to effect decisive victories over credible, though somewhat unprepared enemy forces. The success of these operations has resulted in an increased self-confidence in US tactics and technology while it has raised societal expectations of low casualty military engagements. However, this success has provided some "fog and friction" now working against innovation and effective training. To ensure victory, the Air Force must study the recurring lessons of history, analyze current trends and threats, and then develop a congruent training program to survive the most lethal threats and kill the most critical targets. It must increasingly concentrate on the most recurring need for airpower instead of the most effective use of airpower.

Enemy engagement strategies focus on US strengths and weaknesses. Adversaries adapt to US information superiority and precision strike capability by dispersing into the streets and forests of the world. This reduces airpower's effectiveness and provides an adversary with the optimum setting to inflict American casualties. Potential enemies increasingly rely on surface-

to-air defense systems due to US counterair capability. Surface threats have inflicted the greatest losses to US aircraft in every conflict of the twentieth century.[1]

Another result of US success is the expectation of minimal casualties. US combat capability has evolved to the extent that this is no longer an expectation, but rather a *requirement.* This "requirement" in turn threatens the historic measurement of combat capability.

Military combat capability, first and foremost, strives to survive the threat and kill the target. To that end we need the ability to identify and train towards the most lethal threats and the most critical targets. From the dawn of recorded civilization, Sumerians, Assyrians, Greeks and Romans sought this same objective: to survive the threat and kill the enemy. Before "doctrine" occupied daily thought and language, these militaries sought to "organize, equip and train" to survive and kill. Peripheral commitments and training that detract from these skills threaten baseline combat capability.

Surface-to-air defense systems are the most lethal threats to Air Force aircraft. Radar-guided surface-to-air missiles (SAM), infrared tracking SAMs, and anti-aircraft artillery (AAA) exist worldwide in greater concentrations and longer ranges than do less prolific air threats. Since 1965, dense AAA and thousands of SAMs have claimed more than 1,500 Air Force aircraft while enemy MiGs have accounted for 66 USAF losses.[2] Despite this disparity, USAF fighter training has overwhelmingly sought to master air-to-air (A/A) survival skills in comparison to more lethal and prevalent surface threats.

While enemy SAMs and AAA are the most lethal threats to Air Force aircraft, low-contrast battlefield targets remain the most elusive targets for strike aircraft to kill. Battlefield targets obscured by foliage, weather and terrain remain nearly as difficult to locate and kill today as they did in the 1960's. Global positioning system (GPS) technology greatly improves weather

delivery capability but initial detection in adverse conditions has improved to a lesser degree. Decades of conflict provide the catalyst for innovation, but the lack of a true all-weather attack capability is partially due to a peacetime fixation on strategic attack.[3]

During the 1960's, the USAF possessed no dedicated air or ground threat training. A/A sorties were largely conducted as in-squadron similar intercept training.[4] The Air Force maintained numerous nuclear-strike trained aircrew but lacked a credible CAS capability in its multi-role tactical aircraft.[5] The majority of air-to-ground (A/G) training took place in clear flats of Arizona and Nevada as Cold War missions rarely involved searching for targets under poor weather or thick foliage.[6]

The sting of Vietnam forced clear perception and initiative. In the late '70s, the Air Force embarked on training improvements to enhance aviator mission exposure.[7] The 66 Air Force aircraft lost to enemy MiGs during the Vietnam War were honored by an intense air-to-air regimen complete with professional adversaries.[8] Although exercises would come to include surface threat emitters, the nearly 1,500 USAF aircraft lost to surface threats did not provide the catalyst to initiate a surface threat training syllabus.[9]

Gulf War aviators benefited greatly from pre-war air-to-air training while learning a costly ground threat lethality lesson in the opening days of the war. Today, surface threats still challenge US aircraft over Iraq while accounting for every single USAF combat loss over the past 25 years.[10]

Lethal surface threats and elusive surface targets are airpower lessons that have haunted aviators from The Somme to Pristina. These recurring lessons now combine with emerging trends to further threaten CAF lethality. Global trends that impede our information dominance, standoff, mobility and firepower adversely impact our combat capability. Increases in urban

combat and SAM/AAA proliferation stem partially from US information superiority and air dominance.[11] The counter to these adverse trends is congruent training towards the most recurring *need* for airpower instead of the most doctrinally effective *use* of airpower. Although air superiority and strategic attack are the most essential and decisive airpower capabilities, CAF training must increasingly focus on ground threats and battlefield targets versus air threats and exposed targets.

Notes

[1] Kenneth P. Werrell, *Archie, Flak, AAA and SAM* (Maxwell Air Force Base, Alabama: Air University Press, 1988), 177.

[2]Air Force Systems Command, 78.

[3] Lambeth, Benjamin S., *The Transformation of American Air Power* (New York: Cornell University Press, 2000), 49.

[4] Mathew P. Donovan, *Full Circle? The Transformation of Dedicated Adversary Air Training in the USAF,* School of Advanced Airpower Studies, (Maxwell Air Force Base, Alabama, June 1998), 8.

[5] L.C. Rush Jr., *Close Air Support Challenges for the Air Force and Army in 2010 Battlespace,* Naval War College, (Newport Rhode Island, 2 June 1997), 25,40.

[6] Lambeth, 59.

[7] Ibid, 59.

[8] Ralph T. Browning. *Aggressor Training: Where Has it Gone? How to Get it Back.* (Armed Forces Staff College. Norfolk, Virginia, 6 May 1977), 3.

[9] Air Force Systems Command, 74.

[10] Keaney

[11] Peters, Ralph. *Fighting for the Future – Will America Triumph?* (Mechanicsburg, PA: Stackpole Books, 1999), 90.

Chapter 2

Recurring Lessons from US Victories and Defeats

Threats That Continue to Kill Us

> *When I took over my Wing in Vietnam, the big talk wasn't about the MiGs, but about the SAMs. There's something terribly personal about the SAM; it means to kill you…it rearranges your priorities. The truth is you never do get used to the SAMs; I had about two hundred fifty shot at me and the last one was as inspiring as the first.*
>
> —Brigadier General Robin Olds
> *Change of Command*

The 10:1 kill ratio of the Korean War had an immense impact on USAF training. Put simply, the Air Force had developed a superiority complex. Realistic air-to-air training gave way to a perception that regarded tactical fighters primarily as a means for delivering nuclear weapons.[1] The emphasis on nuclear doctrine and overconfidence in high-tech missiles combined with safety concerns virtually removed visual maneuvering from daily flight training.[2] The USAF paid for this training regimen and misperception with a 2.4:1 kill ratio for the entire Vietnam War.[3]

As the guns fell silent in Southeast Asia, earnest efforts to improve USAF flight training began in the western deserts of the United States. The disappointing losses to North Vietnamese Air Force (NVAF) MiGs led to the creation of the US Navy Fighter Weapons School (TOPGUN), USAF Aggressor adversary squadrons and Red Flag.[4] Air Force air-to-air training advanced from pre-war basic intercept training to large force dissimilar aircraft combat training

(DACT) where aviators trained *exclusively against air threats*.[5] The USAF established Aggressor squadrons in every operating theater to provide realistic training and to brutally highlight inferior tactics. USAF Aggressor strength grew to 72 aircraft with the Tactical Air Command (TAC) objective of "visiting every fighter wing three times per year."[6]

Although these air-to-air training improvements proved extremely successful, dedicated surface-to-air threat training never developed to the same level. This imbalance is surprising given that almost 90 percent (1,492) of the 1,676 Air Force aircraft lost in Vietnam were lost to enemy SAMs and ground fire while 4 percent (66) came from NVAF MiGs.[7] Aircraft maneuvers vary greatly between surface-to-air and A/A threat survival, but the lack of threat emitters or a structured threat defense syllabus provided only isolated opportunities for aviators to perform threat defense maneuvers. Red Flag and Cope Thunder exercises incorporate threat emitters into their scenarios, however this training is only available when units deploy to these exercises.[8] Meanwhile, multi-role fighter Initial Qualification Training (IQT), Mission Qualification Training (MQT), and Continuation Training (CT) programs dedicate large training portions to air-to-air proficiency with numerous air-to-ground sortie events dedicated to A/A skills.[9]

Even the loss of 97 Israeli Air Force aircraft to surface threats in 1973 failed to initiate a building block syllabus to train *exclusively against ground threats*.[10] Leading into Desert Storm, the lone cadre of aviators who arguably trained against dedicated surface threats, were USAF F-4G Wild Weasels.[11]

The training regimen that Air Force tactical aviators took into Desert Shield/Storm varied from similar 1 V 1 to dissimilar 8 V X with minimal effort dedicated to surface threat training.[12] The last Aggressor deployment took place in 1990 to prepare the 33rd Tactical Fighter Wing for

their deployment to the Persian Gulf.[13] Except for what had been learned on the Nellis and Fallon ranges, there would be no last minute development of a Surface Threat Aggressor Unit to further prepare aviators for Desert Storm.

The results of Desert Storm speak for themselves; Air Force fighter aircraft scored 31 A/A kills compared to zero losses.[14] "The fighter aircrews flying in the Gulf represented the training zenith of the extensive DACT programs in the Air Force throughout the 1980's. Almost to a man, all the shooters were the products of Nellis training, be they Fighter Weapons School graduates, former Aggressors, or at least had many Red Flag and Aggressor training sorties in their backgrounds. We simply cannot ignore this lesson of history."[15]

The 14 USAF combat losses during Desert Storm all came from surface threats. The coalition had 38 combat losses with 37 attributed to surface threats.[16] Aircraft survival statistics from Desert Storm indicate the value of dedicated threat defense training. USAF F-4G Wild Weasels were older and more regularly engaged with surface threats when compared to Air Force F-15Es, Navy F/A-18s, USMC AV-8Bs and coalition Tornado GR-1s. Yet, the F-4Gs, arguably the only pre-war aircraft to regularly *train to dedicated surface threats*, suffered lower combat loss rates than all of these newer and more maneuverable aircraft. [17]

The greatest air losses of Desert Storm came from low altitude tactics.[18] Despite numerous low altitude losses during the Korea and Vietnam Wars, in the absence of peacetime surface threat aggressors, Iraqi ground fire and shoulder launched SAMs served up a painful lethality lesson.[19]

In the past ten years, the USAF has been continuously engaged in contingency operations over Iraq and conflicts in the Balkans. During this time, CAF training has followed the focus of the '80s with more emphasis on air-to-air survival in comparison to more prolific surface

threats.[20] Numerous CAF weapons school graduates support the assertion that few, if any, Air Force fighter squadrons fly building-block training missions *exclusively against surface threats* while routinely training exclusively against air threats.[21]

Individual surface-to-air threat defense skills are paramount for survival. During contingency operations, over 700 Air Force aircraft have been engaged by Iraqi AAA and SAM systems.[22] Over 700 SAMs were shot at coalition aircraft during Allied Force resulting in 2 USAF losses.[23] In most of these engagements, the time required for a suppression of enemy air defense (SEAD) aircraft to place a High-Speed Anti-Radiation Missile (HARM) on an enemy SAM normally exceeded the flyout time of the SAM.[24] Although equally critical in terms of required survival skills, the Air Force has experienced comparatively minimal opposition from any air threat since Desert Storm.[25]

The lesson of Vietnam was the value of dedicated adversary threat training. Desert Storm confirmed the benefits of a rigorous DACT program and dedicated adversaries. Following the historic trends from Korea, Vietnam, and Desert Storm, US contingency operations and Balkan conflicts provide the recurring lesson that the greatest threat, and the greatest training need, still comes from the ground up.

Targets That Continue to Elude Us

Our basic job over here is to bomb targets, not chase MiGs.

—Brigadier General Robin Olds
Change of Command

As surface threat lethality is the greatest recurring lesson to aircraft survival, the need for all-weather CAS/interdiction skills is the most recurring offensive airpower lesson. Every major US conflict of the twentieth century has required the engagement of CAS/AI targets in adverse environments. In World War I, the Allied Meuse-Argonne offensive used CAS as a substitute for artillery until the weather halted flight operations.[26] In World War II, the 101st Airborne Division waited for clear weather and 9th Air Force CAS aircraft to attack surrounding German units and enable a breakout.[27]

A desperate ground situation, poor weather and political restrictions resulted in the majority of Korean War missions being dedicated to interdiction and CAS.[28] "So desperate was the plight of the ground forces that even the B-29s were committed almost exclusively to interdiction attacks."[29] "Interdiction, armed reconnaissance and close air support accounted of 67 percent of all Far East Air Force (FEAF) sorties flown."[30] The so-called "strategic" war in Korea lasted less than two months accounting for just 0.2 percent of FEAF combat sorties.[31]

> CAS and interdiction missions in Korea were of greater importance to the success of American efforts than in any previous conflict. However, many of the advances (from WWII) toward an effective C2 system were either stymied or even reversed. In the early days of the war, CAS was often the first priority for air assets. United Nations command (UNC) ground forces weaknesses in field artillery, especially heavy artillery, forced UNC air units to concentrate on CAS. CAS was to play a decisive role during the initial North Korean invasion and the subsequent Chinese intervention.[32]

Political restrictions during the Vietnam War effectively diverted the majority of fighter missions towards interdiction and CAS.[33] Nearly 75 percent of all sorties were flown in support

of ground forces and much of this took place in an environment fraught with adverse weather and terrain.[34]

> At the time of this report, unfavorable weather precludes the delivery with any consistent accuracy, of ordnance by any aircraft/weapon systems employed in SEA [Southeast Asia]. The impact of adverse weather on air operations…can be expected to affect: tactics, target and ordnance selection, maneuvering parameters, delivery accuracy, and vulnerability to enemy defenses.[35]

> Much of South Vietnam….is covered with dense forests, jungle, and mangrove. Utilization of this natural concealment has afforded the enemy great tactical and logistical advantages vis-à-vis Allied forces. A paramount military problem from the outset, therefore, has been the difficulty of locating the enemy, his bases, his LOCs. Without information about enemy dispositions, our forces cannot exploit their advantage of superior firepower.[36]

There were huge CAS and BAI efforts in Vietnam including over 24,000 sorties in support of the 26th Marine Regiment in Khe Sanh.[37] The North Vietnamese attack at Khe Sanh destroyed over 98 percent of available ammunition stocks and isolated the marines from any possible land units.[38] The never-ending CAS effort killed an estimated 10,000 NVA troops with 1,057 Marine casualties attributed to the NVA assault.[39]

Yet initial CAS efforts in Vietnam neglected many of the air-to-ground lessons of Korea. "Prior to the Vietnam War, the Air Force's preoccupation with support to the national strategy of massive retaliation caused it to focus its organizing, training, and equipping on general nuclear war."[40] This training not only focused on nuclear weapons but also on targets seldom found under triple canopy jungle.[41] After Vietnam, training quickly reverted back to the nuclear threat in Europe at the expense of locating and killing low-contrast targets.[42] "The F-4 was deployed to Europe as a multi-purpose fighter to support US commitments to NATO. Its primary mission is to fulfill NATO's nuclear strike commitment."[43]

While a resounding airpower success, Gulf War aviators trained in the deserts of Nellis, Fallon, Yuma, and the National Training Center to fight a robust Soviet threat. Training

opportunities were supported by strong defense budgets for an aviator cadre free from proficiency-draining contingency operations.[44] The US was blessed with a six-month training period before engaging an exposed *conventional* adversary.[45]

Despite these attributes and few situations with "troops in contact," the air campaign still required low-altitude CAS in poor weather conditions.[46] Weather over the deserts of Iraq was so bad that the air campaign was "absolutely beat down," to a point where it saw the "whole pace of the campaign disastrously affected."[47] When the ground offensive began on 24 February 1991, "CAS forces were still required to support ground maneuvers despite the relentless pounding of enemy positions."[48]

After Desert Storm, the US engaged in the Balkans where the problem of low-contrast battlefield targets remained. "Numerous Deliberate Force missions were cancelled or rated non-effective due to the characteristically adverse weather conditions in the Balkan region at that time of year."[49] "The rules of engagement (ROE) required positive identification of the assigned designated mean point of impact (DMPI) before dropping bombs, and that was not always possible because of bad weather."[50] Adverse Balkan weather resulted in more than half of the Allied Force aircraft return without expending any ordnance.[51] This recurring lesson results largely from insufficient emphasis and training towards locating and killing low-contrast targets.

USAF air-to-ground training has historically focused on the most effective *use* of airpower instead of the most common *need* for airpower. Air Force doctrine emphasizes the success of strategic attack efforts in the WWII Combined Bomber Offensive, Linebacker II, and Desert Storm, while minimizing counterland effects echoed from Chosin, Khe Sanh, and Khafji.[52] The Tet offensive of 1968 and the Kosovo campaign of 1999 attest to potential conflict where a "halt" phase may not begin until enemy troops engage friendly ground forces or civilians.

The checkered history of preserving US counterland expertise between conflicts is described in USAF Counterland Doctrine. "While the end of World War II, the Korean War, and the war in Vietnam each saw AI and CAS procedures honed to a fine art, the period after each of those conflicts saw a marked decline due to other priorities."[53]

In contrast to the repeated neglect of all weather CAS/AI skills, nuclear training always receives the highest priority. The US military possesses a robust nuclear capability in it's bomber, ICBM, and submarine forces. Nuclear training is at the heart of their mission but comes at a steep price for tactical aviators. Vietnam era F-100, F-105 and F-4 aviators lost valuable CAS/BAI training while preparing for nuclear operations. TAC manuals *directed* training programs to master tactical nuclear operations at the expense of conventional combat capability.

> Nuclear training will in every instance take precedence over non-nuclear familiarization and qualification. It is emphasized that conventional training will not be accomplished at the expense of higher priority nuclear training required by this manual. Non-MSF [mobile strike force] units will restrict conventional familiarization to the accomplishment of only one event per aircrew per year.[54]

F-111 and F-16 aircrew suffered the same fate entering Desert Storm.[55] More recently, F-15E aircrew tasked with CAS/AI missions over the Balkans, while overly familiar with tactical nuclear weapons, had very limited exposure to CAS operations. According to the 1998 Joint Strategic Capabilities Plan: "Training emphasis for units apportioned to the SIOP [Single Integrated Operational Plan] should favor SIOP over other training taskings."[56]

Insufficient training against lethal threats and low-contrast targets are the peacetime lessons of USAF history. The Air Force had a fog of air dominance entering Vietnam from a superior Korean War record and the advent of new high-tech missiles. Post-Vietnam training showed clarity for rigorous air-to-air training but insufficient emphasis on surface threats and all-weather surface attack. Strong efforts were made after Desert Storm to procure all-weather air-to-ground

weapons, but actual training to attack ground targets in adverse conditions continues to receive insufficient emphasis.

The late ground offensive in Desert Storm and the absence of friendly troops in Kosovo kept operating altitudes above the most lethal threat envelopes.[57] This trend may change in a world of unpredictable urban conflict and increased peace operations. Peace operations require "troops in contact" and air support in a dangerous environment. Despite the desire to remain above the reach of surface threats, history proves that when troops are placed in harm's way, aircraft are expected to take the fight to the enemy regardless of the threat situation.[58] In light of Desert Storm and Allied Force combat losses, training programs have failed to adequately address surface threat lethality. Increased peace operations and urban combat are only a few of the emerging trends that threaten CAF combat capability. If training programs fail to align to these trends, the survival of aviators and friendly troops will rest on forgotten skills from forgotten battles.

Notes

[1] Donovan, 8.
[2] Ibid, 8.
[3] Lambeth, 45.
[4] Ibid, 59.
[5] Donovan, 2.
[6] Browning, 3.
[7] Air Force Systems Command, 78.
[8] Michael Skinner. *Red Flag: Air Combat for the '80s* (Novato, California: Presidio Press, 1984), 7.
[9] Headquarters USAF Air Combat Command, *USAF Basic Qualification Training Course F-15E,* (Langley Air Force Base, Virginia, February, 2000) The F-15E Basic Course syllabus provides for roughly 85 aerial engagement opportunities and 21 surface-to-air engagments. F-15E and F-16 TX Course and Continuation training follow a similar ratio.
[10] Lambeth, 55.
[11] Hans Halberstadt. *The Wild Weasels.* (Osceola, WI: Motorbooks International Publishers, 1992), 22.
[12] Donovan, 18.
[13] Ibid, 25.

Notes

[14] United States General Accounting Office, GAO/ NSIAD-97-134, *OPERATION DESERT STORM: Evaluation of the Air Campaign,* (Washington, DC: Government Printing Office, 1997), 171.

[15] Donovan, 27. Quoted from interview with Colonel Ricardo Cazessus, USAF vice commander, 57th Wing, Nellis AFB, Nevada, 17 March 1998.

[16] Keaney, 651.

[17] Ibid, 651.

[18] Lambeth, 120.

[19] Ibid, 120.

[20] Headquarters USAF Air Combat Command, *USAF Basic Qualification Training Course F-15E,* (Langley Air Force Base, Virginia, February, 2000) The F-15E Basic Course syllabus provides for roughly 85 aerial engagement opportunities and 21 surface-to-air engagments. F-15E and F-16 TX Course and Continuation training follow a similar ratio.

[21] Major William Reese, Major Mike Gantt, Captain Chris Niemi, Major Joe Guastella, interviewed by author, January and February 2001.

[22] Tirpak, John A., "Airpower in the Gulf: 10 Years Later." *Air Force Magazine,* January 2001, 26.

[23] Chaisson, Kernan. "NATO kept Serb air defenses busy." *Journal of Electronic Defense;* Norwood; Aug 1999, 18.

[24] Lambeth, 199.

[25] "Operation Southern Watch," "Operation Northern Watch," "Operation Provide Comfort," "Operation Deny Flight," 3 Mar 2001, available on-line from www.fas.org. and "Southwest Asia War Aerial Victories" available from www.maxwell.af.mil/au/afhra. An "engagement" in this context is defined as an actual firing of air-to-air ordnance. The USAF has been involved in 16 air-to-air engagements since Desert Storm. Starting with the Southern Watch Mig Kill on 27 Dec 92, the USAF has had 2 engagements in Operation Southern Watch, 3 engagements in Operation Provide Comfort, 2 engagements in Operation Deny Flight, and nine engagements during Operation Allied Force.

[26] United States War Department General Staff, *Blanc Mont: The Meuse-Argonne Campagne*, (Washington: Government Printing Office, June, 1921).

[27] Hugh M. Cole, *The Ardennes: Battle of the Bulge,* (Washington D.C., Office of the Chief of Military History, Department of the Army., 1965), 468.

[28] USAF Historical Division Liaison Office, *USAF Tactical Operations – World War II and Korean War with Statistical Tables,* 1962, 157.

[29] James T. Stewart. *Airpower – The Decisive Force in Korea,* (Princeton, N.J.:D. Van Nostrand Company, Inc., 1957), 280.

[30] Ibid. p157

[31] Ibid. p280.

[32] Rush, Quoted in Benjamin F. Cooling(ed.), *Case Studies in the Development of Close Air Support,* (Washington D.C.: US Government Printing Office, 1990), 345.

[33] Mark Clodfelter. *The Limits of Air power, the American Bombing of North Vietnam,* (New York: The Free Press, 1989), 134.

[34] Spencer Tucker. *Encyclopedia of the Vietnam War: a political, social and military history,* 1998, 13.

Notes

[35] Headquarters Pacific Air Forces, Directorate, Tactical Evaluation Project CHECO, *Impact of Darkness and Weather on Air Operations in SEA*, 11 Mar 69. P.79 (S) Declassified on 20 Nov 91.

[36] Headquarters Pacific Air Forces, Directorate, *Tactical Evaluation Project CHECO, Impact of Geography on Air Operations in SEA,* 11 June 1970. (S) Declassified on 21 Nov 91.

[37] Lambeth, 22.

[38] Ibid, 22.

[39] Ibid, 23.

[40] Rush, 25.

[41] Lambeth, 59.

[42] Department of the Air Force, Tactical Air Command Manual 51-50 Volume 1, *Flying Training - Tactical Aircrew Training,* 1 Oct 78 and 30 Oct 85, Langley AFB, Va. P. A1-5 Table A1-2. F-111 aircrew sortie requirements directed more sorties towards nuclear training than all other types of training (PGM, Conventional, etc.) F-4 and F-16 sortie requirements directed more sorties to nuclear training than all other types of training (night conventional, Maverick, GBU-15, Loran, Wild Weasel Support, ACBT, etc.) except for day conventional.

[43] James R. Alley, *Should F-4 Aircrew in USAFE be Specialized* (Air Command and Staff College, Maxwell AFB, Alabama, May 1974), 9.

[44] Lambeth, 71 and Rush, 42.

[45] Rush, 42.

[46] Elsarelli, 19.

[47] Lambeth, 144. Notes quoted from General Buster Glosson's diary in *Air War in the Persian Gulf,* 178.

[48] Elsarelli, 18.

[49] Robert C. Owen, Colonel, USAF, *Deliberate Force – A Case Study in Effective Air Campaigning,* (Maxwell Air Force Base, Alabama, Air University Press, January, 2000), 114,138.

[50] Ibid.

[51] Lambeth, 184.

[52] Air Force Doctrine Document (AFDD) 2-1.2, *Strategic Attack*, 20 May 98, 2-13.

[53] Ibid, p83.

[54] Lambeth, 36. Quoted from *Aircrew Training for F-100D/F, TAC Manual 51-6 Vol. 1* (Langley AFB, VA, March 1961).

[55] Tactical Air Command Manual (TACM) 51-50, Table A1-2 Sortie Requirements, 30 Oct 85.

[56] Chairman of the Joint Chiefs of Staff Manual 3110.01A*, Joint Strategic Capabilities Plan,*(S) 1 Dec 98, p. B-3. This portion Unclassified.

[57] Elsarelli, 17.

[58] Elsarelli, 18.

Chapter 3

A Brave New World - Trends and Threats to CAF Lethality

Roman legions, while rarely defeated, were astonished by the savagery of their opponents. The Romans so cherished their civilized image of themselves…so loved the law, that it blinded them to barbarian strength.

—Ralph Peters
Fighting for the Future

Many comparisons can be made to the unipolar worlds of ancient Rome and modern America. Both powers relied on strong militaries for political strength. Both militaries dominated the conventional battlefield and suffered losses in guerilla campaigns. Sustained exposure to these two dominant militaries acted to sharpen the skills and tactics of their unconventional enemies. Rome and the United States each garrisoned forces on far-away shores much longer than originally expected. Much like a no-fly zone, beginning with Hadrian, Rome's deployed legions labored more to *contain* enemies rather than drill to conquer them.[1] "Rome's military disintegration in the fourth century can be traced to one essential: her legions were no longer invincible, nor were they perceived to be so by her enemies."[2]

These 1,600 year-old lessons, like the lessons in the preceding chapter, remain applicable to the modern Expeditionary Air Force (EAF). Optempo, combat capability, barbarians, urbanization, casualty sensitivity, and weapons proliferation defined major challenges facing Roman legions as they now define current challenges for CAF training. No analysis of future

conflict is 100 percent accurate but examining several emerging global trends provides valuable insight to guide CAF training.

The US experience in Somalia includes many trends of modern conflict. Mogadishu had swelled in population due to starving masses in the countryside while warlords wielded the real power in the city.[3] The urban battlefield restricted mobility as concerns for collateral damage and noncombatant casualties restricted firepower.[4] Fixed wing urban CAS was unavailable and the unconventional Somali air defenses inflicted moderate losses to Army helicopters.[5] "We faced urban warriors and found that their resilience in the face of massive casualties was greater than our political will as we suffered comparatively few."[6] The urban melee did not differ greatly from a World War I or II street battle or, for that matter, a primitive tribal conflict from 5000 years ago. It reaffirms the adage that: "technologies come and go, but the primitive endures."[7] Now imagine a city like Mogadishu with a SAM on its hospital.

Opstempo and Combat Capability

> *Our strength is based mainly on the pilot and not the weapon system…Top grade pilots will achieve magnificent results even with less superior aircraft, but the bad pilot in a good aircraft has no impact on the aircraft's performance.*
>
> —Israeli Air Force Training Manual

The dramatic increase in USAF contingency operations in the face of force reductions is well documented. The US Air Force is 40 percent smaller than it was during the Cold War, yet the rate at which it is employed has risen by a factor of four. Combat unit readiness has dropped well over 20 percent and the mission capability rates of aircraft are down by 10 percent over the last decade.[8]

CAF aviators get virtually no effective training towards the skills required for combat employment during contingency operations. The effects of contingency flying are discussed in a

RAND Corporation report comparing the current fighter force with the force that fought in Desert Storm.

> Comparatively, during the 1980's, virtually all the time US military aircrew spent in the air was high-quality training time. These crews performed exceptionally well in Operation Desert Storm, and this performance was due to combat skills honed during the final years of the Cold War. The extensive commitment of USAF personnel to peace operations in the years since the Gulf War ended has come largely at the expense of high-quality training time. Consequently, relative to the forces that fought and won the Gulf War, today's Air Force is both smaller and on average, less proficient at basic combat tasks.[9]

This observation reflects a fighter force of the '80s raised on Aggressors and Red Flag, compared to a force of the '90s raised on contingency operations.

This analysis is also confirmed by both informal and formal reviews of Red Flag and Weapon School performance. According to former 57th Wing Commander, Major General Theodore Lay III, "we have seen a significant decrease in capability of units and individuals in Weapons School and Red Flag because we are not training as we did even six or seven years ago. Some of this time we spend in the desert drilling holes and making people experienced in orbits but not engagements, and part of it is because they develop bad habits flying similar [air combat training] every day."[10] A Congressional report of US Navy and Air Force air combat training also assesses the status of our current fighter force:

> One of the most far-reaching problems identified at both Fallon [Naval Air Station] and Nellis [Air Force Base] is the declining skill level of pilots in the operational force. While it was noted that Weapon School students were still strong on classroom knowledge, new students are less proficient in key skill areas. We are producing a combat pilot cohort that, while not second rate, compares poorly to what the Navy and Air Force have produced in the past.[11]

Continually high optempo also has an adverse affect on aviator retention. Many squadrons struggle with less than 50 percent of their aviators falling into the "experienced" category.[12] An "experienced" tactical aviator is defined as having 500 hours of flight time in assigned aircraft.[13] A recent RAND study on the Air Force pilot shortage states that "declining

experience levels in flying units confronts the Air Force with its most serious problem….serious enough to compromise the ability of fighter units to accomplish their primary missions and meet AEF demands"[14] The net result of a smaller force, higher optempo, lower aircraft mission capable rates, less experience and less flying is a significant reduction in CAF lethality. It is imperative that the available forces focus on locating and killing low-contrast targets in a surface threat environment. Until that occurs, effectively dispensing that lethality will remain an elusive science.

Minimizing Collateral Damage and Casualties

Just as high optempo degrades combat capability, increased restrictions to offensive firepower reduce lethality as well. Political restrictions can totally eliminate a once valid target from a targeting list. Public opinion and public support are increasingly centers of gravity (COG) for US operations with collateral damage and friendly casualties comprising two of the biggest factors affecting public opinion.[15]

Collateral damage in war is as old as war itself. Real-time news coverage in the Gulf War introduced unprecedented levels of concern for collateral damage. The images of the demolished Al Fidros bunker immediately curtailed attack sorties into Baghdad, effectively achieving what Iraqi air defenses failed to accomplish during three weeks of air attacks.[16] Airmen faced similar pressure during Allied Force following inadvertent strikes on the Chinese embassy and Kosovar refugees.

Press coverage of American casualties also affects US combat capability. The graphic abuse of a fallen US soldier in Mogadishu accelerated America's departure from Somalia.[17] Two years later, the loss of an F-16 during Deny Flight resulted in Combat Air Patrols (CAP) being pulled back to the Adriatic for nearly two months.[18] Whether casualty avoidance and collateral damage

minimization represent sound national policy or a hobbling obsession is immaterial. However, they have unquestionable effects on combat capability and must be included in realistic training.

SAM Proliferation

SAM proliferation is a growing threat to American aviators. US adversaries are acutely aware of US air-to-air dominance and limited SEAD capability. The limited success of Serbian air defenses and the inability of Iraq to defend against US aircraft make the newer SA-10/12 a top acquisition priority for many developing countries. The USAF reports that more than 14 countries already have weapons equivalent to the Russian-made SA-10 and SA-12, and estimates that 24 countries will have such weapons by 2005.[19] When compared to older SAMs, these newer missiles are faster, more maneuverable, and have larger engagement zones. They give off fewer electronic indications and warnings to SAM suppression and target aircraft, making them less susceptible to jamming and countermeasures.[20] These SAMs are capable of engaging six times as many targets as older systems.[21] SAMs that had been recently relocated engaged and brought down two aircraft during Allied Force. These new SAMs are very mobile specifically for this type of operation. One of the most challenging tactical scenarios is the presence of a SA-10/12 in an urban environment.

Urban Warfare

Urban conflicts are some of the most hazardous military operations. The US has traditionally bypassed cities during wartime operations. Yet urban warfare is rapidly becoming a predominant form of modern conflict.

The main reason that a large percentage of future conflict will take place in cities is the sheer demographics of a changing world. Estimates suggest that more than 85 percent of the world's population will live in urban areas by 2015.[22] Despite the costs and hazards of urban operations,

they are already the norm for some US forces. The Marine Corps has been involved in urban operations in 237 of it's last 250 deployments.[23]

The other reasons for an increase in urban warfare are US strengths and weaknesses. American strengths lie in mobility, surface firepower, airpower and information dominance against conventional forces. Urban battlefields weaken each of these strengths while providing a guerilla force with optimal hit-and-run terrain. Just as the Serbs dispersed forces into the austere Kosovo countryside, potential enemies can easily disperse assets inside urban terrain.

"Adversaries often view casualty sensitivity as the United States' "center of gravity" and adopt their strategies accordingly."[24] Urban settings provide the highest probability for media to broadcast images of American or noncombatant casualties back to the US. Urban terrain restricts air and surface firepower due to concern for collateral damage. Urban environments also enable enemy forces to mix and mingle with noncombatants to force close combat. That is just one characteristic of the new "warrior-class" we face in the cities.

The Warrior Class

World demographics describe the environment of future conflict and the resource challenges for developing nations. A new warrior class grows from this struggle to control and terrorize the cities of the world. Ralph Peters in *Fighting for the Future,* describes this new warrior class:

> We will often face men who have acquired a taste for killing, who do not behave rationally according to our definition of rationality, who are capable of atrocities that challenge the descriptive powers of language and who will sacrifice their own kind in order to survive. We will face opponents for whom treachery is routine, whose sole motivation to refrain from killing is the fear of being killed, for whom peace is the least rewarding human condition, and they will not be impressed by tepid shows of force with restrictive rules of engagement. When we drive the warriors into a corner or defeat them, they will agree to anything. When our attention is elsewhere, they will break the agreement. Their behavior, natural to them, is unthinkable to us. And then they massacre.[25]

A guerilla warrior is not an insurmountable opponent alone or even en masse. He is however, the most incompatible adversary for US military structure, psyche and training.[26] Whether fighting in the cities or in the countryside, guerilla warriors will not mass their fielded forces. The warrior thrives and terrorizes in the city while CAF training and resources are structured to locate and kill conventional threats on the deserts, plains, and fields of the world.[27] Americans live and breathe respect for life and the law while the warrior often possesses neither of these values.[28] A warrior is normally prepared to absorb the hardship, collateral damage, and casualties from an attack better than the US system is prepared to deliver such an attack.[29]

Guerilla warriors historically never give nor expect any quarter from their enemies. This is exemplified by the statistics from US aviators ejecting over South Vietnam compared to those over North Vietnam. Despite the proximity of friendly ground and search and rescue (SAR) forces, 60.8 percent of USAF aviators who ejected over North Vietnam survived the egress while only 42.1 percent survived an egress over Viet Cong held South Vietnam.[30] Failure to understand this warrior class is what leads to a "superpower unable to travel five city blocks of Mogadishu a full twenty years after placing a dune buggy on the moon."[31] Acknowledging these emerging trends and their affect on combat capability is the first step to innovation and congruent training.

Notes

[1] Robert L. O'Connell. *Of Arms and Men – A History of War, Weapons, and Aggression,* (New York: Oxford University Press, 1989), 82.

[2] Ibid, 81.

[3] "An Introduction to Somalia: Somalia – Operations Other Than War," *Special Edition* No 93-1, n.p.; on-line, Internet, 25 February 1999, available from http://call.army.mil.spc_edtn/93-1/tbl_con.htm.

[4] "Ambush in Mogadishu," 1998, n.p.; on-line, Internet, 26 Feb 1999, available from http://www.pbs.org/wgbh.pages/frontline/shows/ambush/

[5] Ibid.

[6] Peters, 55.

Notes

[7] Ibid, 171.

[8] United States Air Force Document (U), *The United States Air Force Posture Statement 1999*, 5.

[9] Alan Vick et al., *Preparing the U.S. Air Force for Military Operations other than war* (Santa Monica, California: RAND Corporation, 1997), 28, 37.

[10] Donovan, 42. Notes from Brigadier General Theodore W. Lay III, commander, 57th Wing, memorandum to Brigadier General Daniel M. Dick, director of plans and programs, Air Combat Command, subject: Aggressor Force Structure Request, 5 February 1998.

[11] Charles Spinney. *Congressional Report on Navy and Air Force Air Combat Training,* 30 Jan 2000, 2.

[12] William Taylor, et al., *The Air Force Pilot Shortage: A Crisis for Operational Units,* (Santa Monica California, RAND Corporation 2000), 12.

[13] Air Force Instruction (AFI) 11-2F-16 volume 1, *Flying Operations: F-16 Aircrew Training,* 1 May 1998, 89.

[14] Adam J. Hebert, "Learning to Live with the Pilot Retention Problem." *Air Force Magazine,* January, 2001,67.

[15] Troy E. Devine, *The Influence of America's Casualty Sensitivity on Military Strategy and Doctrine* (Maxwell Air Force Base, Alabama: School of Advanced Airpower Studies, June 1997) 10.

[16] William G. Adamson. *The Effects of Real-Time News Coverage on Military Decision Making,* (Maxwell Air Force Base, Alabama: Air Command and Staff College March 1997), 18.

[17] Devine, 47.

[18] Ibid, 54.

[19] Tirpak, John A., "Can the Fighter Force Hold Its Edge?" *Air Force Magazine,* January, 2000, 29.

[20] Ibid, 29.

[21] Ibid, 29.

[22] Paul, Mann. "Urban War Requires New Technologies." *Aviation Week and Space Technology,* 5 July, 1999, 56.

[23] Ibid, 55.

[24] Daniel L. Byman, and Matthew C. Waxmen, *Kosovo and the Great Air Power Debate,* International Security, Vol 24 No. 4 (Spring 2000), 32.

[25] Peters, 46, 187.

[26] Peters,15.

[27] Ibid, p71.

[28] Ibid, p191.

[29] Ibid, p181,187.

[30] Air Force Systems Command, 4.

[31] Peters, 18.

Chapter 4

The Road Ahead – Congruent Training for Upcoming Tasks

> *The erosion of sorties and experience in operational units has limited the potential for operational units to train themselves to any predictable end. The requirement exists to develop new methods that keep pace with the threat and efficiently employ available assets. The emphasis on realism, manifested by aggressor squadrons, Red Flag, etc. is required to test the training product in combat scenarios.*
>
> —Major John P. Jumper
> 1978 ACSC Student Thesis

CAF opstempo, retention and experience levels require that every sortie align with the skills that permit maximum survivability and lethality. Training must reflect expected wartime tasks as indicated through lessons, trends, and the global security environment.

Congruent Surface Threat Training

Surface threats have destroyed over 1,500 Air Force aircraft in the past 35 years and accounted for every single USAF loss over the past 25 years.[1] Over 700 SAMs were fired at coalition aircraft during Allied Force and another 700 surface threat engagements have occurred during contingency operations over Iraq. In light of minimal surface threat training, the proliferation of advanced SAMs indicates an increasingly deadly threat to Air Force aircraft. Higher opstempo and lower readiness indicates that today's aviators are less experienced and less proficient than the forces that flew in Desert Storm.

Several Weapons School sorties are allocated against dedicated surface threats however; this type of structured training is unavailable to younger aviators. Current CAF surface threat training is simply not congruent with the growing threat, frequency of engagements, and expected survivability. If the Air Force is unprepared to bolster this aspect of training then it must significantly bolster SEAD and CSAR assets and training.

Recommendation: Administer Surface-to-Air Threat Defense training *exclusively against ground threats* with the same methodology applied to air-to-air training. Initiate building block threat defense training progressing from medium altitude single-ship to low altitude formation tactics. Utilize existing Red Flag, Cope Thunder and EW range emitters for dedicated threat defense training. In the author's opinion, this is the single most important training initiative required to improve CAF survivability and lethality.

Congruent Air-to-Air Training

High optempo/low experience aviators are increasingly challenged by Red Flag scenarios and the Weapons School syllabus. Their daily training is impaired by requirements to generate red-air support for "blue" proficiency. This normally results in training against identical aircraft with identical electronic, radar, and visual signatures. Red air support requirements also drain sorties that could be used for surface-to-air threat defense training. Levied red-air requirements for the upcoming F-22 OT&E, Weapons School support, and Red Flag adversary support will further task an overextended CAF fighter force with missions that offer no measurable gain in combat capability.

Current CAF training is supported by only 8 percent of pre-Desert Storm adversary support aircraft.[2] The USAF achieved Gulf War air superiority in the first days of conflict achieving a 31 to 0 air-to-air kill ratio.[3] The adversary support available to today's aviators more closely

resembles the limited DACT training opportunities prior to 1973.[4] The USAF lost 66 aircraft to enemy MiGs during the Vietnam War desperately trying to regain air-to-air proficiency.[5]

Recommendation: Reinstate the Aggressors to their former strength and purpose. Combine Air National Guard F-16s with Navy Reserve F/A-18s to establish Joint Adversary Training Squadrons. The F-16/F-18 mix would maximize dissimilar training opportunities and improve threat replication. Operations would focus on Carrier Task Force and Air Expeditionary Force deployments to prepare frontline aviators for deployments and worldwide threats. This initiative would allow active-duty Navy and Air Force fighter pilots to concentrate on required air-to-air skills and essentially return "blue" training back to active-duty aviators. Fewer red air support requirements would also enable increased sorties for surface-to-air threat defense training.

Locating and Killing Low-Contrast Targets

History echoes the recurring lesson of low-contrast battlefield targets. Increased peace operations indicates increased situations with troops-in-contact and a continuing demand for CAS and interdiction skills. Few multi-role fighter units perform even a minimum amount of CAS training.[6] The CAS training which is performed seldom includes adverse weather or urban targets. CAS employment in either urban terrain or adverse weather requires increased levels of coordination. Accordingly, aviators must train in these environments to attain the required proficiency to safely execute CAS in adverse weather and terrain.

The center of gravity of a guerilla army is often the fielded and dispersed army itself. The Air Force's *Find-Fix-Track-Target-Engage-Assess* (F^2T^2EA) attack continuum against low-contrast targets must obviously start with the "find" aspect.[7] This can only happen if the shooter is autonomously capable of finding the target or receives a sensor-to-shooter link to guide it to the "target" and "engage" phase.

US information and surveillance assets are essential for this support. Despite this requirement, units rarely, if ever, train with Joint Surveillance Target Attack Radar System (JSTARS) aircraft, unmanned aerial vehicles (UAV), or U-2 imagery.[8] Current unit training to find and kill low contrast targets is not congruent with prevailing needs and expectations.

Recommendation: Surface attack training must concentrate on killing low-contrast targets protected by mobile threats instead of exposed targets with fixed defenses. Training in coordination with information, surveillance and reconnaissance platforms provides needed CAS/interdiction skills. Increased CAS skills are required from every multi-role fighter including skills required in an urban environment. This flexibility and coordination will also serve to improve strategic attack skills. Squadron training should utilize available Marine Corps and Army urban ranges as units participate in urban warfare exercises.

Paying the Bill

Nothing is free in business including the business of killing. Therefore, training sorties for threat defense, increased blue air-to-air, and urban CAS must come from existing operations and maintenance (O&M) accounts. Joint or ANG aggressors can absorb a high percentage of red air sorties for the upcoming F-22 OT&E, Weapons School syllabus, Red Flag and AEF training. This provides enough blue air training to increase air-to-air readiness and start a threat defense training program. Reducing sorties dedicated to strategic attack will enable adequate sorties for threat defense and CAS without adversely affecting strategic attack capability. The return on this investment is a more lethal and a more survivable force.

Conclusion

Past lessons and current trends that affect combat capability are undeniable. Adapting daily training to these lessons and trends will help aviators survive the greatest threats and kill the toughest targets. Dedicated surface threat training and dedicated adversaries will ensure that new technology SAMs and MiGs will be unable to inflict unacceptable losses. Training to engage low-contrast battlefield and urban targets will prepare Air Force fighters for the greatest recurring and upcoming airpower challenge. Minimal realignments to the CAF training regimen will pay for the implementation of this training program. The Air Force cannot allow the ineptitude of recent adversaries to provide the US with an air of general superiority and it cannot wait for a catastrophic military failure to provide the catalyst towards innovation.

Notes

[1]Keaney, 651.
[2] Donovan, 1.
[3] Ibid, 4.
[4] Ibid, 4.
[5] Air Force Systems Command, 78.
[6] Reese.
[7] Tirpak, John A., "Find, Fix, Track, Target, Engage, Assess." *Air Force Magazine,* July 2000, 24-29.
[8] Reese.

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